

Fire plays an important role in shaping the ecological and environmental dynamics of the western boreal. Post-fire successional dynamics in uplands are well understood by the Healthy Landscapes Program, but there are gaps in understanding these processes in other ecosystems. Understanding ecosystem recovery across all ecosystem types is critical for a whole landscape approach to ecosystem-based management.

This factsheet provides an overview of wetland successional dynamics following wildfire. However, like uplands, changes in wetland fire behaviour (Factsheet Fire Behaviour) including **increased fire frequency, intensity, and severity can adversely impact the re-establishment of pre-fire conditions.**^{1,2} This means

that our understanding of successional dynamics based on historic fire regimes may not reflect recovery from current and future wildfires. Understanding the impacts of wetland fires is a growing, but relatively new field.

Wetlands and Wildfire Refugia

Wildfire rarely results in a uniform and all-encompassing burn across the landscape. Instead, it often leaves patches of unburned vegetation. When areas repeatedly escape fire, they may be referred to as **refugia**. Refugias are typically influenced by topography, with flat areas facilitating fire spread. In the western boreal where there is little topographical relief, **wetlands are critical wildfire refugia**, with their high soil moisture content and ecology.³ This does not mean that wetlands do not burn, but rather have a lower probability of burning, and typically do not burn as severely as uplands. Wetlands that act as refugia help shape post-fire ecosystem processes by:

- Acting as gene banks for regenerating burn areas where seeds, rhizomes and other plant reproductive elements are preserved, limiting changes to species composition post fire,
- Acting as fire breaks by preventing spread to adjacent ecosystems, and
- Promoting areas of refugia, for vegetation and wildlife (such as boreal caribou) in both wetlands and in upland forest adjacent to hydrologically connected peatlands, such as fens.³

The spatial variations in burn severity serve as key indicators for post-fire regeneration and species composition.^{2,4} Microtopography emerges as a critical factor in this context, particularly with *Sphagnum*-dominated dry hummock communities serving as noteworthy indicators. These hummocks, retaining higher levels of moisture and tend to experience less severe burns.^{1,4} However, when wetlands are dry (e.g., drought or disconnected from ground water by anthropogenic disturbance) they may no longer act as refugia, but rather as wicks.

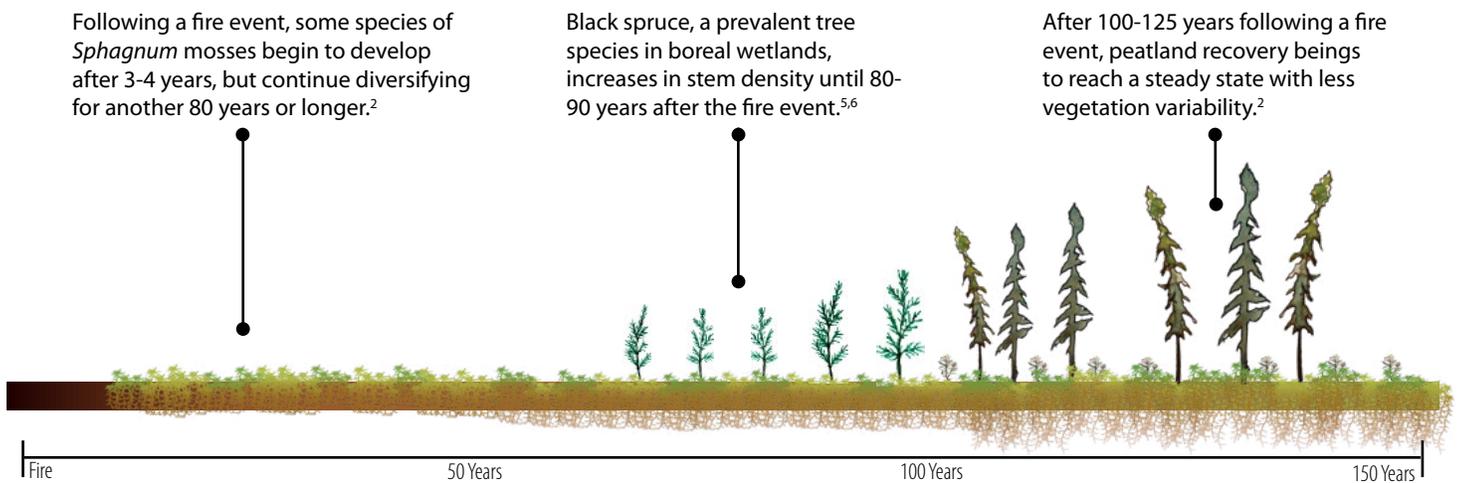


Post- Fire Wetland Vegetation

Most wetland succession research has focused on treed organic wetlands, with a gap in the literature related to other wetland types. In studied organic wetlands, low-intensity and severity fires result in a post-fire nutrient flush that can stimulate vegetation growth and enhance peat accumulation, with rapid recovery of species such as *Sphagnum* mosses.¹ When this occurs, peat accumulation stabilizes quickly and net peat accumulation is not impacted.¹

Factors that influence wetland recovery include:²

- **Pre-fire site conditions:** Vegetation composition, seed bank, presence of disturbance (i.e. harvesting or wetland draining), and soil moisture conditions.
- **Severity of the burn:** How deep the burn penetrates into the peat profile.
- **Time since last fire:** The amount of time that has passed since the last time the peatland burned.
- **Climate variability:** Climate trends and long-term fire weather such as prolonged wet periods or drought.

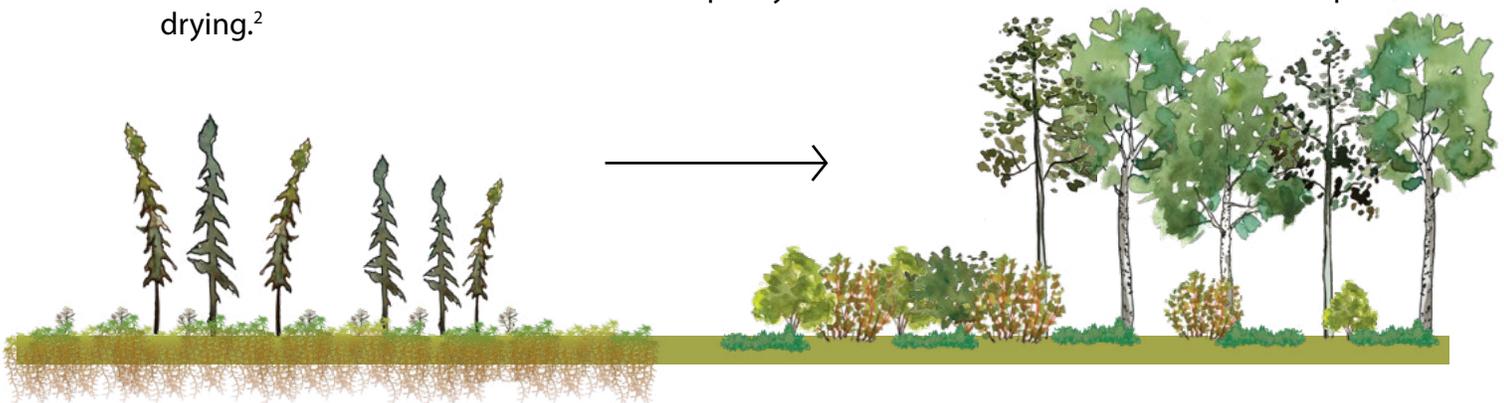


Impacts of Climate Change on Fire and Wetland Succession

Increased temperatures due to climate change are expected to often result in warmer and drier wetland conditions. Consequences of these trends that then effect wetland wildfire and post-wildfire succession include:

1. Shifts in vegetation composition towards a more terrestrial landscape, characterized by:

- Increasing tree and shrub biomass, particularly evident in shrub-dominated wetlands.²
- In organic wetlands, moss composition shifting from *Sphagnum*-dominated to feather moss-dominated. Feather mosses have less capacity for water retention and are more susceptible to drying.²



2. *More severe burns resulting in deeper smouldering potential, longer-lasting fires, and greater carbon release.*

When dry to due to climate or land use changes, organic wetlands with deep peat soils are particularly susceptible to severe burns. This is because there is abundant sub-surface fuel available to burn (dry peat) and fire can **penetrate protective moss layers** crucial for regulating surface moisture and water storage.^{2,7} Severe fires in organic wetlands can overwinter (smoulder below the ground surface), **release large amounts of carbon**, and burn deep into the peat profile.^{4,8} Severe fires in peatlands also reprodize these wetland's refugia potential, such as completely eliminate most or all of a wetland's gene bank.

3. *Increased fire frequency under future climate scenarios creates uncertainty in upland and wetland ecosystem recovery trajectories.*²

Historic fire return intervals for treed boreal wetlands are estimated to be 100 to 120 years or longer.^{2,9} However, historic return intervals may not be indicative of current or future intervals as **the frequency and severity of wildfires have increased and are predicted to continue increasing.**^{1,2} This increase in fire return is expected to ²:

- Reduce viable seed load, the number of seedlings, conifer density
- Change soil characteristics
- Change the vegetation communities of wetlands and surrounding forests
- Release substantial amounts of carbon dioxide into the atmosphere
- Increase permafrost thaw
- Potentially release legacy metals into air and water systems

WATER REPELLENCY IN WETLANDS POST-FIRE

After a wildfire, the hydrology of burned wetlands undergoes significant changes that result in decreased surface evaporation. This reduction in surface evaporation can be due to the development of a water-repellent layer either on the wetland's surface or in the near-surface soil layers after the fire.¹⁰ These dynamics have been studied in organic wetlands with deep peat soils, but are likely to occur in other wetland types.

High soil temperatures can cause organic substances to bond to soil particles, resulting in water repellency in previously hydrophilic soils.¹⁰ This bonding process creates water-repellent layers within the soil, causing water droplets to bead on the surface instead of infiltrating the soil profile. Additionally, the water-repellent layer acts as a physical barrier to the capillary rise of water from the water table to the wetland's surface, reducing moisture lost through evaporation.¹⁰

The extent of this effect depends on fire severity and vegetation species, with more water repellency observed in feather mosses than in *Sphagnum*.¹¹ The increased water repellency following a fire can enhance wetland resilience by reducing evaporation, which contributes to a higher water table and helps protect wetland soils from decomposition.



Resources:

- Jones, E. (2021). Wildfire return intervals: impacts of diminishing fire return intervals on boreal peatlands using combined field/lidar approaches. University of Lethbridge (Canada).
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- Kuntzemann, C. E., Whitman, E., Stralberg, D., Parisien, M. A., Thompson, D. K., & Nielsen, S. E. (2023). Peatlands promote fire refugia in boreal forests of northern Alberta, Canada. *Ecosphere*, 14(5). <https://doi.org/10.1002/ecs2.4510>



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2. Jones, E. (2019). Wildfire return intervals: impacts of diminishing fire return intervals on boreal peatlands using combined field/lidar approaches.
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10. Kettridge, N., Humphrey, R. E., Smith, J. E., Lukenbach, M. C., Devito, K. J., Petrone, R. M., & Waddington, J. M. (2014). Burned and unburned peat water repellency: Implications for peatland evaporation following wildfire. *Journal of Hydrology*, 513, 335–341. <https://doi.org/10.1016/j.jhydrol.2014.03.019>